REMARKS

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Respectfully submitted,

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Attached is a marked-up version of the changes being made by the current amendment.

Version with markings to show changes made

In the specification:

Replace the paragraph beginning at page 1, number [0004] with the following rewritten paragraph:

Feher's Patent QPSK ("FQPSK") is a spectrally efficient form of offset QPSK modulation which uses pulse shaping in order to reduce spectral side[ ]lobes, and cross-correlation between its in-phase ("I") and quadrature phase ("Q") baseband signals, in order to maintain a nearly constant [single] signal envelope. These characteristics of FQPSK may make this format desirable for communication[s] in nonlinear, bandwidth-constrained channels.

Replace the paragraph beginning at page 2, number [0005] with the following rewritten paragraph:

A special form of [FPQSK] FQPSK described in U.S. Patent Nos. 4,567,602 and 5,491,457 , is known as [FPQSK-B] FQPSK-B [, is] . This is a baseband filtered version of FQPSK which is more spectrally efficient than unfiltered FQPSK and thus is [which may be] useful in limited bandwidth channels. However, the bandwidth limiting of FQPSK-B comes at the expense of bit error rate degradation [. FQPSK-B is more spectrally efficient than unfiltered FQPSK, but may have] caused by the introduction

of intersymbol interference due to the baseband filtering. [For example, a traditional receiver for PQPSK-B may have a bit error rate of 1.4 dB at 10^{-3}.]

Replace the paragraph beginning at page 2, number [0008] with the following rewritten paragraph:

A trellis-coded interpretation of FQPSK is known. The FQPSK signal is generated by transmitting one of 16 different shaped waveforms. The basic waveform shapes are shown in Figure 1. Eight unique waveforms are shown in Figure 1. Eight other shapes, which are the negatives of those waveforms, are also used. These [waveforms] waveshapes characterize [form a] the 16 state trellis that represent the optimum Viterbi receiver for FQPSK (or FQPSK-B). [[0009]] A full-blown system of this type, [however] while feasible, may be too complex for a [real] commercial implementation.

Replace the paragraph beginning at page 3, number [0010] with the following rewritten paragraph:

The present application teaches a special Viterbi receiver [which] that has reduced complexity but still has bit error rate advantages over a symbol-by-symbol detection type receiver. According to an embodiment, he waveforms forming the FQPSK-B

[waveforms] signals are grouped in a special way to create a simpler trellis[.], i.e., one with fewer states. This receiver [may] will still provide significant gain over conventional FQPSK-B receivers, while reducing the complexity that would otherwise be inherent in an optimum FQPSK-B Viterbi receiver.

Replace the paragraph beginning at page 4, number [0016] with the following rewritten paragraph:

Figure 5 shows a block diagram an embodiment of a simplified FQPSK-B receiver [of an embodiment]; and

Replace the paragraph beginning at page 4, number [0018] with the following rewritten paragraph:

The present application invention defines a reduced complexity alternative system. This system [may] forms a simplified FQPSK-B Viterbi receiver with a reduced number of correlators and trellis states. For example, the receiver may have a factor of 4 fewer correlators in the receiver, and a factor of 8 fewer [algorithm] trellis branch computations.

Replace the paragraph beginning at page 4 number [0019] with the following rewritten paragraph:

In an embodiment, the 16 possible FQPSK-B waveforms are divided into 4 groups. Each group may include signals, for

example, which have some similar characteristic. An FQPSK signal is received. This signal is correlated against the average of the waveforms in each group. The signals are appropriately grouped, as described herein, in a way that reduces the FQPSK trellis from a 16-state trellis with 4 transistions per state [into] to two independent two-state trellises with only two transistions per state. Due to the similarity between the PQPSK-B waveforms, this reduced-complexity receiver only has a small E_b/N_0 penalty as compared with a full-blown Viterbi receiver. However, if offers significant performance gains as compared to the conventional FQPSK-B receiver. Special characteristics of this receiver are hence described.

Replace the paragraph beginning at page 5, number [0020] with the following rewritten paragraph:

A traditional commercial FQPSK-B receiver includes a sample-and-hold receiver that carries out symbol-by-symbol detection. The received signal is [down converted] downconverted to baseband. The baseband signal is then filtered using a detection filter [whose bandwidth-symbol period (BT_s) is approximately 0.6]. The output of the detection filter is

sampled, and a decision [about contents] on the transmitted signal is made [about the specific signal].

Replace the paragraph beginning at page 5, number [0021] with the following rewritten paragraph:

[The] [i]Intersymbol interference [may] introduced by the input filter will increase the bit error probability of this receiver. Figure 2 shows a comparison between the 32 term theoretical approximation of bit error probability, and the computer simulated results. [Figure 2 shows a comparison with ideal FQPSK.] This is further compared with the bit error probability of ideal QPSK in the figure.

Replace the paragraph beginning at page 6, number [0022] with the following rewritten paragraph:

A traditional FQPSK-B Viterbi receiver is shown in Figure 3. This receiver [may] correlates the baseband received signal with the 16 FQPSK waveforms, and uses [a] the Viterbi. [technique in order] Algorithm (VA) to perform trellis decoding. The Viterbi [technique] algorithm [may] searches [through the 4] along the translations [of the 16] between states of [a] the FQPSK trellis to find the path with the largest accumulated

branch metric. The 16 Viterbi [A] algorithm branch metrics Z_j are defined as follows:

$$Z_j = R_j - \frac{E_j}{2} \qquad j = 0,\ldots,15 \qquad (1)$$

[   ]where R_j is the correlation of the received signal and the jth waveform[s], and E_j is the energy [in] of the jth waveform. The correlation values R_8 through R_{15} are obtained by taking the negatives of R_0 through R_7 respectively. For example, R_0=R_8. A total of 16 correlations are needed, with 8 correlators being needed for the in-phase signals and 8 correlators being needed for the quadrature phase signals. The "Viterbi [A] algorithm" block 350 [may] carr[y]ies out the subtraction of $E_j/2$ from the value R_j.

Replace the paragraph beginning at page 6, number [0024] with the following rewritten paragraph:

A simplified FQPSK-B Viterbi receiver is described with reference to Figures 4 and 5. In this embodiment, sets of waveforms are grouped together in order to create a reduced trellis. In the embodiment, the waveforms C_0, C_1, C_2 and C_3, [effectively] as represented by the top row in Figure 1, are grouped into a first group. As can be seen by investigating these waveforms, each of the waveforms have "similar" properties. A second group is formed of the second row in Figure

1, including the waveforms C_4, C_5, C_6, and C_7. For example, C_0-C_3 each represent waveforms which [are primarily towards the top of the graph] have small or no deviation from a constant. Similarly C_4-C_7 represent waveforms which [extend from the bottom of the graph on one side to the top of the graph on the other side] have small or no deviation from a sinusoid. That is, the[se] waveforms within each group are spectrally similar, so that the combination[s] (average) of these waveforms may also be spectrally similar to each of the waveforms being averaged. [A second group is formed of the second row in Figure 1, including the waveforms C_4, C_5, C_6, and C_7.] [Similarly,] [t] The third group of waveforms is formed [of] from C_8-C_{11}, and a fourth group of waveforms is formed [of] from C_{12}-C_{15}. This grouping enables the trellis-coded structure to be divided into two independent, in-phase and quadrature, two-state trellises.

Replace the paragraph beginning at page 7, number [0025] with the following rewritten paragraph:

Figure 5 shows a block diagram of the modified receiver. The received signal 500 is filtered by 502 and demodulated by demodulator 504. The demodulated signals include an in-phase signal 508 and quadrature signal 509. The in-phase signal 508 is delayed [by] a half symbol by delay element 507. The

demodulated signal is correlated against the average of the waveforms in each group. Four correlators 510, 512, 514, 516 are used for this correlation. The average values are show in Figure 4, and obtained as:

Equations

Replace the paragraph beginning at page 8, number [0026] with the following rewritten paragraph:

Since [q2] $\underline{q_2}$ and [q3] $\underline{q_3}$ are respectively the negatives of q_0 and q_1. [Hence,] [o] Only two $\underline{q_2,\ q_3,\ q_0,\ q_1,}$ correlators are needed for each of the I and Q channels. The same Viterbi [A] algorithm metric is used in equation 1, except that [Ej] $\underline{E_j}$ [which is used is] now represents the energy of the group average waveform $q_j(t)$.

Replace the paragraph beginning at page 8, number [0027] with the following rewritten paragraph:

Figure 6 shows a trellis including group signals with two states and two transitions [in each] per state. The dual Viterbi techniques for the I and Q channels can hence be combined into a single 4 state VA. Compared with the full Viterbi receiver, this simplified receiver may have 12 fewer

correlators, and an eight-fold reduction in the number of Viterbi [A] algorithm computations per decoded bit.

In the claims:

Please amend the claims as follows:

1. (Amended) A receiver, comprising:

a plurality of averaged waveforms, each said averaged waveform comprising an average of a plurality of FQPSK[-B] waveforms; [and]

a plurality of correlators, [using a trellis code] to correlate an input signal with each of said averaged waveforms of said plurality to form correlations; and

a trellis decoder using said correlations to make decisions on the transmitted signals.

2. (Amended) A receiver as in claim 1, wherein said plurality of averaged waveforms each represent four FQPSK[-B] waveforms.

3. A receiver as in claim 1, further comprising an input filter which filters an input signal.

4. (Amended) A receiver as in claim 1, further comprising a demodulator, receiving an input signal, and producing demodulated complex signals.

5. (Amended) A receiver as in claim 4, wherein said demodulated complex signals include an in-phase signal and a quadrature signal component.

6. (Amended) A receiver as in claim 2, wherein there are four of said correlators to [demodulate] correlate said FQPSK[-B] waveforms.

7. (Amended) A receiver as in claim 1, wherein each of said plurality of averaged waveforms include a plurality of basic FQPSK[-B] waveforms which have similar characteristics.

8. (Amended) A receiver as in claim 7, wherein each averaged waveform[s] comprised a combination average of four FQPSK[-B] waveforms.

9. (Amended) A method, comprising:

obtaining a plurality of basic waveforms which represent trellis waveforms for FQPSK or FQPSK-B;

averaging groups of said plurality of waveforms to form averaged waveforms, wherein a number of said averaged

waveforms is less than a number of said plurality of waveforms; and

correlating an FQPSK-B input signal against said averaged waveforms to [demodulate said input signal] <u>form a group of signals to be processed by a trellis decoder</u>.

10. A method as in claim 9, wherein said averaging groups comprises averaging four of said FQPSK-B waveforms to form each averaged waveforms.

11. A method as in claim 9, further comprising filtering an input signal, and wherein said correlating comprises correlating against a filtered input signal.

12. (Amended) A method as in claim 9, further comprising producing demodulated signals form input signals <u>and a set of correlation from said demodulated signals</u>.

13. (Amended) A method as in claim 12, wherein said demodulated signals include an [in phase] <u>in-phase</u> signal and a quadrature signal.

14. (Amended) A method as in claim 9, wherein said correlating comprises using four of said correlators to [demodulate] <u>correlated the demodulated inphase and quadrature input signal with</u> said FQPSK-B waveforms.

15. A method as in claim 9, wherein said plurality of averaged waveforms include a plurality of waveforms which have similar characteristics.

16. A method as in claim 9, wherein each averaged waveforms comprise a combination of four FQPSK waveforms.

17. A receiver, comprising:

a filter element, receiving an input FQPSK-B signal and producing a filtered FQPSK-B signal; and

a Viterbi Algorithm receiver, producing demodulated signals based on said FQPSK-B input signals.

18. A receiver as in claim 17, wherein said Viterbi Algorithm receiver compares said filtered FQPSK-B signal with a plurality of averaged signals.

19. A method of receiving an FQPSK-B signal, comprising:

obtaining a plurality of basic FPQSK-B signals associated with modulation of an FQPSK-B signal;

averaging said plurality of basic FQPSK-B signals to form a plurality of averaged signals; and

comparing an input coded FQPSK-B signal with said plurality of averaged signals to carry out the modulation.

20. A method as in claim 19, wherein there are 16 of said basic FQPSK-B signals, and wherein there are four of said averaged signals.

Please add the following new claim.

<u>21. (New) A receiver as in claim 1, wherein said FWPSK waveform are FQPSK or FQPSK-B, waveforms.</u>